



**CHEMISTRY**  
**HIGHER LEVEL**  
**PAPER 1**

Thursday 10 May 2001 (afternoon)

1 hour

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**INSTRUCTIONS TO CANDIDATES**

- Do not open this examination paper until instructed to do so.
- Answer all the questions.
- For each question, choose the answer you consider to be the best and indicate your choice on the answer sheet provided.

1 <b>H</b> 1.01		Atomic Number																2 <b>He</b> 4.00																	
3 <b>Li</b> 6.94		4 <b>Be</b> 9.01		Atomic Mass																9 <b>F</b> 19.00															
11 <b>Na</b> 22.99		12 <b>Mg</b> 24.31																		17 <b>Cl</b> 35.45															
19 <b>K</b> 39.10		20 <b>Ca</b> 40.08		21 <b>Sc</b> 44.96		22 <b>Ti</b> 47.90		23 <b>V</b> 50.94		24 <b>Cr</b> 52.00		25 <b>Mn</b> 54.94		26 <b>Fe</b> 55.85		27 <b>Co</b> 58.93		28 <b>Ni</b> 58.71		29 <b>Cu</b> 63.55		30 <b>Zn</b> 65.37		31 <b>Ga</b> 69.72		32 <b>Ge</b> 72.59		33 <b>As</b> 74.92		34 <b>Se</b> 78.96		35 <b>Br</b> 79.90		36 <b>Kr</b> 83.80	
37 <b>Rb</b> 85.47		38 <b>Sr</b> 87.62		39 <b>Y</b> 88.91		40 <b>Zr</b> 91.22		41 <b>Nb</b> 92.91		42 <b>Mo</b> 95.94		43 <b>Tc</b> 98.91		44 <b>Ru</b> 101.07		45 <b>Rh</b> 102.91		46 <b>Pd</b> 106.42		47 <b>Ag</b> 107.87		48 <b>Cd</b> 112.40		49 <b>In</b> 114.82		50 <b>Sn</b> 118.69		51 <b>Sb</b> 121.75		52 <b>Te</b> 127.60		53 <b>I</b> 126.90		54 <b>Xe</b> 131.30	
55 <b>Cs</b> 132.91		56 <b>Ba</b> 137.34		57 † <b>La</b> 138.91		72 <b>Hf</b> 178.49		73 <b>Ta</b> 180.95		74 <b>W</b> 183.85		75 <b>Re</b> 186.21		76 <b>Os</b> 190.21		77 <b>Ir</b> 192.22		78 <b>Pt</b> 195.09		79 <b>Au</b> 196.97		80 <b>Hg</b> 200.59		81 <b>Tl</b> 204.37		82 <b>Pb</b> 207.19		83 <b>Bi</b> 208.98		84 <b>Po</b> (210)		85 <b>At</b> (210)		86 <b>Rn</b> (222)	
87 <b>Fr</b> (223)		88 <b>Ra</b> (226)		89 ‡ <b>Ac</b> (227)		104 <b>Rf</b> (261)		105 <b>Db</b> (262)		106 <b>Sg</b> (263)		107 <b>Bh</b> (262)		108 <b>Hs</b>		109 <b>Mt</b>																			

58	<b>Ce</b>	140.12
59	<b>Pr</b>	140.91
60	<b>Nd</b>	144.24
61	<b>Pm</b>	146.92
62	<b>Sm</b>	150.35
63	<b>Eu</b>	151.96
64	<b>Gd</b>	157.25
65	<b>Tb</b>	158.92
66	<b>Dy</b>	162.50
67	<b>Ho</b>	164.93
68	<b>Er</b>	167.26
69	<b>Tm</b>	168.93
70	<b>Yb</b>	173.04
71	<b>Lu</b>	174.97

90	91	92	93	94	95	96	97	98	99	100	101	102	103
<b>Th</b>	<b>Pa</b>	<b>U</b>	<b>Np</b>	<b>Pu</b>	<b>Am</b>	<b>Cm</b>	<b>Bk</b>	<b>Cf</b>	<b>Es</b>	<b>Fm</b>	<b>Md</b>	<b>No</b>	<b>Lr</b>
232.04	231.04	238.03	(237)	(242)	(243)	(247)	(247)	(251)	(254)	(257)	(258)	(259)	(260)

1. 10.0 cm<sup>3</sup> of 0.200 mol dm<sup>-3</sup> H<sub>3</sub>PO<sub>4</sub>(aq) is converted into Na<sub>2</sub>HPO<sub>4</sub>(aq). What volume (in cm<sup>3</sup>) of 0.200 mol dm<sup>-3</sup> NaOH(aq) is required?
  - A. 10.0
  - B. 13.3
  - C. 20.0
  - D. 30.0
  
2. The reason for the general increase in ionisation energy of the elements across period 3 of the Periodic Table is the increasing number of
  - A. outer electrons.
  - B. neutrons.
  - C. protons.
  - D. electron sub-levels occupied.
  
3. Which molecule has the greatest polarity?
  - A. Fluorine
  - B. Hydrogen fluoride
  - C. Hydrogen chloride
  - D. Tetrafluoromethane
  
4. Which is the best description of metallic bonding?
  - A. The attraction between oppositely charged ions
  - B. The attraction between protons and electrons
  - C. The attraction between positive ions and delocalised electrons
  - D. The attraction between nuclei and electron pairs

5. Which compound is the most soluble in water?

- A. Methane
- B. Propane
- C. Propan-1-ol
- D. Pentan-1-ol

6. Which change will have the greatest effect on the pressure of a fixed mass of an ideal gas?

	<b>Volume</b>	<b>Temperature / K</b>
A.	Doubles	Halves
B.	Doubles	Doubles
C.	Halves	Halves
D.	Halves	Remains constant

7. Which process is endothermic?

- A.  $\text{H}_2\text{O(g)} \rightarrow \text{H}_2\text{O(l)}$
- B.  $\text{H}_2\text{O(l)} \rightarrow \text{H}_2\text{O(s)}$
- C.  $2\text{H}_2\text{(g)} + \text{O}_2\text{(g)} \rightarrow 2\text{H}_2\text{O(l)}$
- D.  $\text{H}_2\text{O(g)} \rightarrow 2\text{H(g)} + \text{O(g)}$

8. An experiment was carried out to measure the enthalpy change of solution of sodium hydroxide when a small amount of it is dissolved in water.  $x$  mol of sodium hydroxide was dissolved in  $y$  g of water, giving a temperature rise of  $z$  °C. The specific heat capacity of water is  $c$  J g<sup>-1</sup> K<sup>-1</sup>. Which expression should be used to calculate the molar enthalpy change (in J mol<sup>-1</sup>)?

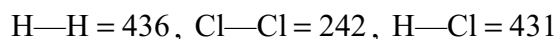
A.  $\frac{xyz}{c}$

B.  $\frac{xy}{cz}$

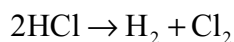
C.  $\frac{c}{xyz}$

D.  $\frac{cyz}{x}$

9. Some average bond enthalpies (in kJ mol<sup>-1</sup>) are as follows:



What is the enthalpy change (in kJ) for the decomposition of hydrogen chloride?



A. -184

B. +184

C. +247

D. -247

10. The reaction between nitrogen and oxygen in the atmosphere under normal conditions is extremely slow. Which statement best explains this?

A. The concentration of oxygen is much lower than that of nitrogen

B. The molar mass of nitrogen is less than that of oxygen

C. The frequency of collisions between nitrogen and oxygen molecules is lower than that between nitrogen molecules themselves

D. Very few nitrogen and oxygen molecules have sufficient energy to react

11. The position of equilibrium in a reversible reaction is shifted to the right until it reaches equilibrium again. Which statement must be true for the reaction when the new position of equilibrium is reached?

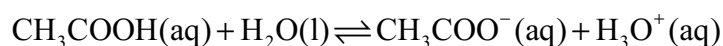
- A. The rate of the forward reaction is greater than the rate of the reverse reaction
- B. The concentrations of reactants and products do not change
- C. The concentrations of reactants and products are equal
- D. The value of  $K_c$  is greater than 1

12. Which change will shift the position of equilibrium to the right in this reaction?



- A. Increasing the temperature
- B. Decreasing the pressure
- C. Adding a catalyst
- D. Removing ammonia from the equilibrium mixture

13. Which of the following represents a conjugate acid-base pair in this reaction?



- A.  $\text{CH}_3\text{COOH} / \text{H}_2\text{O}$
- B.  $\text{CH}_3\text{COOH} / \text{CH}_3\text{COO}^-$
- C.  $\text{CH}_3\text{COOH} / \text{H}_3\text{O}^+$
- D.  $\text{CH}_3\text{COO}^- / \text{H}_3\text{O}^+$

14. Which statement is **not** correct?
- A. Hydrochloric acid can have a pH value of zero
  - B. pH paper contains more than one indicator
  - C. The pH value of an acidic solution decreases when water is added to it
  - D. Dilute hydrochloric acid conducts electricity
15. Which statement about the  $\text{MnO}_4^-$  ion is correct?
- A. An acidified solution of  $\text{MnO}_4^-$  oxidises fluoride ions
  - B. The oxidation number of manganese in  $\text{MnO}_4^-$  is +5
  - C. An acidified solution of  $\text{MnO}_4^-$  oxidises bromide ions
  - D. The oxidation number of oxygen in  $\text{MnO}_4^-$  is +2
16. During the electrolysis of a molten salt, which statement is **not** correct?
- A. The ions only move when a current flows
  - B. Positive ions are attracted to the negative electrode
  - C. Positive ions gain electrons at the negative electrode
  - D. Negative ions lose electrons at the positive electrode
17. Which product is formed from the reaction between  $\text{CH}_3\text{COOH}$  and  $\text{CH}_3\text{CH}_2\text{OH}$ ?
- A.  $\text{CH}_3\text{COOCH}_2\text{CH}_3$
  - B.  $\text{CH}_3\text{CH}_2\text{COOCH}_2\text{CH}_3$
  - C.  $\text{CH}_3\text{CH}_2\text{COOCH}_3$
  - D.  $\text{CH}_3\text{COOCH}_3$

18. Which compound is optically active?
- A.  $\text{CH}_3\text{COCH}(\text{CH}_3)_2$
  - B.  $(\text{CH}_3)_3\text{CCHO}$
  - C.  $\text{CH}_3\text{CH}_2\text{COCH}_2\text{CH}_3$
  - D.  $\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{CHO}$
19. In which pair do both types of compound take part in hydrogen bonding?
- A. Alkanals and esters
  - B. Bromoalkanes and alkanals
  - C. Alkanes and alkenes
  - D. Alkanols and amines
20. Which product is formed in the reaction between ethene and bromine?
- A.  $\text{CHBr}=\text{CH}_2$
  - B.  $\text{CHBr}=\text{CHBr}$
  - C.  $\text{CH}_2\text{BrCH}_2\text{Br}$
  - D.  $\text{CH}_3\text{CH}_2\text{Br}$
21. The separation of ions in a mass spectrometer depends on
- A. only the charge on the ions.
  - B. only the mass of the ions.
  - C. the mass and the charge of the ions.
  - D. only the velocity of the ions.



22. The electronic configuration of chromium (Cr) is
- A.  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^4 4s^2$ .
  - B.  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$ .
  - C.  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^6$ .
  - D.  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^1 4s^5$ .
23. Which could **not** act as a ligand in a complex ion of a d-block element?
- A.  $Cl^-$
  - B.  $NCl_3$
  - C.  $PCl_3$
  - D.  $PCl_5$
24. In which of the following are the compounds  $BF_3$ ,  $CH_4$ ,  $CO_2$  and  $SF_6$  arranged in **decreasing** order of bond angle?
- A.  $BF_3, CH_4, CO_2, SF_6$
  - B.  $BF_3, SF_6, CO_2, CH_4$
  - C.  $CO_2, BF_3, CH_4, SF_6$
  - D.  $SF_6, CO_2, CH_4, BF_3$

25. Which molecule has the longest nitrogen–nitrogen bond length?

- A.  $\text{N}_2$
- B.  $\text{N}_2\text{F}_2$
- C.  $\text{N}_2\text{H}_4$
- D.  $\text{N}_2\text{H}_2$

26. Which species is/are  $\text{sp}^2$  hybridised?

- I.  $\text{C}_2\text{H}_4$
- II.  $\text{C}_2\text{H}_6$
- III.  $\text{C}_3\text{H}_6$

- A. I only
- B. I and II only
- C. I and III only
- D. II and III only

27. Which species contains no delocalised electrons?

- A.  $\text{O}_3$
- B.  $\text{NO}_3^-$
- C.  $\text{CO}_3^{2-}$
- D.  $\text{H}_2\text{SO}_4$

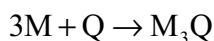
28. In which of the following are the compounds  $\text{CaF}_2$ ,  $\text{CaCl}_2$ ,  $\text{CsF}$  and  $\text{LiF}$  arranged in **increasing** order of lattice enthalpy?

- A.  $\text{CaCl}_2$ ,  $\text{CaF}_2$ ,  $\text{CsF}$ ,  $\text{LiF}$
- B.  $\text{CsF}$ ,  $\text{LiF}$ ,  $\text{CaCl}_2$ ,  $\text{CaF}_2$
- C.  $\text{CaCl}_2$ ,  $\text{CaF}_2$ ,  $\text{LiF}$ ,  $\text{CsF}$
- D.  $\text{LiF}$ ,  $\text{CaF}_2$ ,  $\text{CsF}$ ,  $\text{CaCl}_2$

29. Which reaction has an entropy change closest to zero?

- A.  $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightarrow 2\text{NH}_3(\text{g})$
- B.  $\text{Fe}_2\text{O}_3(\text{s}) + 3\text{CO}(\text{g}) \rightarrow 2\text{Fe}(\text{s}) + 3\text{CO}_2(\text{g})$
- C.  $\text{NH}_3(\text{g}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{NH}_4^+(\text{aq}) + \text{OH}^-(\text{aq})$
- D.  $\text{P}_4(\text{s}) + 4\text{OH}^-(\text{aq}) + 4\text{H}_2\text{O}(\text{l}) \rightarrow 4\text{H}_2\text{PO}_2^-(\text{aq}) + 2\text{H}_2(\text{g})$

30. The reaction



is first order with respect to M and second order with respect to Q. When  $[\text{M}] = 0.100 \text{ mol dm}^{-3}$  and  $[\text{Q}] = 0.020 \text{ mol dm}^{-3}$ , the rate is  $0.010 \text{ mol dm}^{-3} \text{ s}^{-1}$ . What is the value of the rate constant, in  $\text{mol}^{-2} \text{ dm}^6 \text{ s}^{-1}$ ?

- A. 10
- B. 100
- C. 250
- D. 500

31. What is the effect of adding a catalyst to a reaction mixture at equilibrium?
- It decreases the activation energy of the forward reaction and increases the activation energy of the reverse reaction
  - It decreases both the activation energy and the enthalpy change of the forward reaction
  - It decreases the activation energies of both forward and reverse reactions
  - It decreases the activation energies and enthalpy changes of both forward and reverse reactions
32. 10.0 cm<sup>3</sup> of liquid bromine is placed in an empty 100 cm<sup>3</sup> bottle, which is then sealed and left to reach equilibrium at room temperature. What happens first?
- The rate of evaporation is greater than the rate of condensation
  - The rate of condensation is greater than the rate of evaporation
  - The rate of evaporation is equal to the rate of condensation
  - There is no evaporation or condensation
33. The pH value of a  $1.00 \times 10^{-3}$  mol dm<sup>-3</sup> solution of sodium hydroxide is
- 3.
  - 8.
  - 11.
  - 14.
34. Which salt would form a neutral solution when dissolved in water?
- FeCl<sub>3</sub>
  - Na<sub>2</sub>CO<sub>3</sub>
  - KBr
  - NH<sub>4</sub>NO<sub>3</sub>

35. Which factor does **not** affect the value of the standard electrode potential of a half-cell?
- A. The surface area of the electrode
  - B. The concentration of the solution
  - C. The temperature of the solution
  - D. The material of the electrode
36. The mass of a metal deposited during electrolysis does **not** depend on
- A. the current flowing.
  - B. the voltage between the electrodes.
  - C. the time for which the current passes.
  - D. the charge on the metal ion.
37. The infrared spectrum of a compound shows a broad absorption band at  $3325\text{ cm}^{-1}$  and another band at  $1060\text{ cm}^{-1}$ , but no absorption around  $1700\text{ cm}^{-1}$ . Which type of compound is it most likely to be?
- A. Amine
  - B. Alkanol
  - C. Alkanone
  - D. Alkanoic acid
38. Which is a correct description of a free radical?
- A. It is a negatively charged species formed by the homolytic fission of a covalent bond
  - B. It is a neutral species formed by the heterolytic fission of a covalent bond
  - C. It has an unpaired electron and is formed by the heterolytic fission of a covalent bond
  - D. It has an unpaired electron and is formed by the homolytic fission of a covalent bond

39. Which molecule does **not** act as a nucleophile in a reaction with a halogenoalkane?
- A. Ethane
  - B. Ethanol
  - C. Ethylamine
  - D. Water
40. Alkanols can undergo dehydration reactions. Which products could be obtained from the dehydration of ethanol?
- A. Ethane and ethanal
  - B. Ethene and ethanal
  - C. Ethene and ethoxyethane
  - D. Ethanal and ethanoic acid
-